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Heliophysics Theory Program Research Highlight

The Source Region of the Slow Solar Wind

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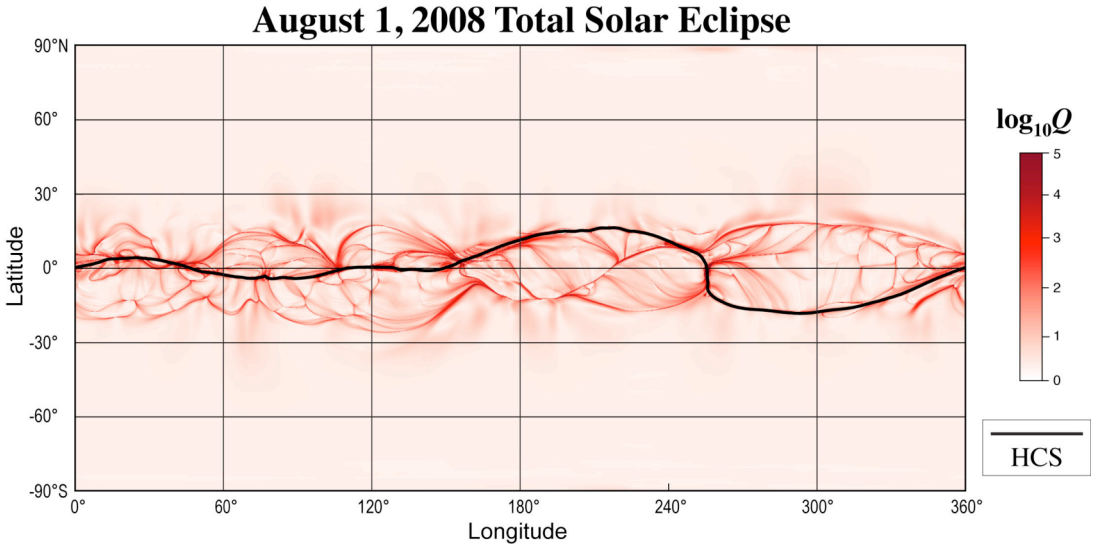
The solar wind is the principal way by which the Sun affects the Earth's magnetic environment. The fast solar wind originates in coronal holes, whereas the slow solar wind is associated with the streamer belt, and is characterized by greater variability and different composition from the fast wind. We have investigated the origin of the slow wind by examining the detailed structure and topology of the coronal magnetic field. Our results offer a novel explanation of observations that have heretofore been a puzzle.

Previously, it was hypothesized that the boundary between the open and closed field regions on the Sun can be extremely complex, with narrow corridors of open flux connecting seemingly disconnected coronal holes. Our work has extended our understanding of how this complexity is manifested in the properties of the slow solar wind. We have found that a parasitic magnetic polarity region can disconnect a coronal hole into two parts. This disconnection produces multiple null points in the corona. Such topologies are favorable for magnetic reconnection. The disconnected parts of coronal holes remain linked by a singular line, suggesting that previous conjectures about the connectivity of coronal holes must be generalized to address the connection of coronal holes in a broader sense (Titov *et al*. 2010).

Via these processes, the magnetic complexity in the photospheric magnetic field produces a web of quasi-separatrix layers (QSLs) and separatrix surfaces that is localized in the broad vicinity of the heliospheric current sheet (HCS). Random photospheric motions can drive interchange reconnection at these sites, releasing plasma with the composition of closed loops into the solar wind. We have hypothesized that this web of separators may be the source of the slow solar wind (Antiochos *et al*. 2010). In the figure we show the structure of the squashing factor Q, which identifies regions of slow wind, during the previous solar minimum. A band of slow wind surrounds the HCS (the black line), explaining how slow wind is observed away from the HCS. Furthermore, this band increases the width occupied by the slow wind, as observed. Future work will attempt to compare the detailed predictions of this model with solar wind observations.

Titov, V. S., Mikić, Z., Linker, J. A., Lionello, R., and Antiochos, S. K. 2010, submitted to *Ap. J.*
Antiochos, S. K., Mikić, Z., Titov, V. S., Lionello, R., and Linker, J. A. 2010, submitted to *Ap. J.*



The corona in August 2008 shows a complex structure with a multitude of quasi-separatrix layers (QSLs) and separatrices (regions with large squashing factor Q) forming a web that is hypothesized to be the source of the slow solar wind. The small-scale magnetic structure in the photosphere maps into a wide band surrounding the heliospheric current sheet (HCS) in the solar wind.